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ONR Basic Research Program: Summary and Bibliographies

Annual Reports 3 and 4, and
Final Report under Grant N00014-96-1-0298

Gary R. Wilson and Elaine C. Frazer

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13. ABSTRACT (Maximum 200 words)

The Office of Naval Research (ONR) sponsored the Basic Research Program, a discretionary grant program for the purpose of giving university laboratory directors freedom to develop and apply their resources to basic research problems of naval relevance, which might not be known or appreciated by others in the community. Program guidelines included (1) involvement of students and faculty and (2) initiation of research in areas that could transition into either core or special research initiative (SRI) programs at ONR.

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1. INTRODUCTION

The subject grant was originally issued on 22 February 1996 in response to Applied Research Laboratories, The University of Texas at Austin (ARL:UT), proposal P-1682 dated 1 November 1995.[1] This grant was funded out of the Office of the Chief of Naval Research (ONR) discretionary block for support of this laboratory as well as the following laboratories: Applied Research Laboratory, Pennsylvania State University (ARL/PSU); Applied Physics Laboratory, University of Washington (APL:UW); and Marine Physics Laboratory, Scripps Institution of Oceanography, University of California at San Diego (MPL:SIO:UCSD). This block is administered by ONR Code 321OA, Dr. John Tague. The purpose of the discretionary grant program is to give the laboratory directors freedom to develop and apply their resources to basic research problems of naval relevance, which may not be known or appreciated by others in the community. The guidelines of the program include (1) involvement of student and faculty and (2) initiation of research in areas that could transition into either core or special research initiative (SRI) programs at ONR.

Modification 6, issued on 22 January 1998, provided support for ARL:UT in FY98, adding $300K to the existing grant. Modifications 7 and 8 provided for administrative changes. Modification 9, dated 21 September 1998, provided $125K in incremental funds. Ten research problems were funded, as shown in Table 1.1. Funding reflects monies received in both Modifications 6 and 9.

Table 1.1
Support for ARL:UT — FY98

Research Project	Principal Investigator	Funding
Development of a CIT constrained electronic density model	Dr. Gary Bust	$39K
Three dimensional electro-magnetic propagation using high performance computing	Dr. Roy Jenevein	$39K

Table 1.1 (cont'd)

Research Project	Principal Investigator	Funding
Identification of elemental composition by electron activated nuclear gamma ray spectroscopy	Dr. Robert Rogers	$39K
Nonlinear methods for early crack detection and localization	Dr. Gary Wilson	$89K
Inversion of ocean wave-guide parameters from measured acoustic data	Dr. David Knobles	$30K
Neutralization of explosives: measured acoustic data	Dr. Dennis Wilson	$30K
Near-field apertureless Raman microscope	Dr. Robert Martinez	$40K
Ultrasonic and sonochemical lysogenesis of bacteria	Dr. Shelley Payne	$40K
Development and evaluation of a multi-state classifier	Dr. G. Douglas Meegan	$39K
High School Apprenticeship Program	Dr. Gary Wilson and Ms. Elaine Frazer	$40K

Modification 10, dated 26 October 1998, provided $325K, which fully funded the grant. Support for ARL:UT in FY99 was based on eight research problems, funded as shown in Table 1.2.

Table 1.2
Support for ARL:UT — FY99

Research Project	Principal Investigator	Funding
Development of a CIT constrained electronic density model	Dr. Gary Bust	$53K
Three dimensional electro-magnetic propagation using high performance computing	Dr. Roy Jenevein	$53K
Identification of elemental composition by electron activated nuclear gamma ray spectroscopy	Dr. Robert Rogers	$53K
Nonlinear methods for early crack detection and localization	Dr. Gary Wilson	$3K
Inversion of ocean wave-guide parameters from measured acoustic data	Dr. David Knobles	$30K
Neutralization of explosives: measured acoustic data	Dr. Dennis Wilson	$39K
Near-field apertureless Raman microscope	Dr. Robert Martinez	$54K
High School Apprenticeship Program	Dr. Gary Wilson and Ms. Elaine Frazer	$40K

Statistics on projects, students, faculty, etc., for the duration of this grant are shown in Table 1.3.

Table 1.3

ONR "ARL" Program

Purpose:

- Seed money - new 6.1 research
- Support UT professors and students on problems of naval relevance
- Support High School Apprenticeship Program

Administration:

- Dr. John Tague, ONR 321OA
- Individual ONR project officers
- ARL IR&D Coordinator

	FY89	FY90	FY91	FY92	FY93	FY94	FY95	FY96	FY97	FY98	FY99
$K	133	299	310	348	370	400	400	400	337	425	325
No. of Active Projects	11	5	6	7	8	7	7	8	7	10	8
No. of Students	11	5	6	7	6	8	9	9	6	8	7
No. of Faculty	9	4	5	6	4	6	4	4	3	5	4

2. RESEARCH RESULTS

The following bibliographical information summarizes the scientific results produced under this grant.

2.1 ARCHIVAL PUBLICATIONS

Bibliographical data are presented here, as well as the abstracts of all papers that appeared in refereed journals. Also included are publications that have been submitted, but are still in the journal editing process.

1. Kim, Jong-Uk, Kyoungjin Kim, Dennis E. Wilson, Dennis R. Peterson, and Noel T. Clemens, "Neutralization of Explosives by Plasma Jet Impingement: Feasibility Study," IEEE Transactions on Plasma Science, Vol. 28, No. 1, February 2000.

Preliminary results of an experimental study to determine the feasibility of neutralizing explosives by impingement of a high-temperature, high-velocity pulsed plasma jet are presented. The pulsed plasma jet was created by an electrothermal gun, a device that relies upon vaporization of solid metal to produce a metal vapor plasma. The tests were conducted using an aluminum plasma with a pulse duration of 1 ms and peak energy of 100 kJ on 1-g specimens of PETN explosive. The specimens were placed inside a chamber at standoff distances of 15-30 cm from the 6.65-mm diameter muzzle of the electrothermal gun. The effectiveness of the plasma impingement was determined by comparing postdetonation experiments on the exposed and unexposed explosive specimens. High-speed imaging of the plasma jet impinging on the explosive and postmortem examination of the explosive specimens suggest that three distinct interactions occur. These interactions are: slow thermal decomposition (burning); raid thermal decomposition (deflagration); and a change in chemistry with negligible or no thermal decomposition. Initial results suggest that these three distinct interactions are a function of the mass flow rate and energy of the plasma.

2. Bust, G. S., D. Coco, and J. J. Makela, "Combined Ionospheric Campaign 1: Ionospheric Tomography and GPS Total Electron Count (TEC) Depletions," Geophysical Research Letters, 27(18), 2000.

Results from the June 1998 combined ionospheric campaign (CIC) are presented. The CIC represents an attempt to focus a large number of different instruments on one interesting geophysical region. The Center for Ionospheric Research (CIR) at Applied Research Laboratories, the University of Texas at Austin (ARL:UT), has had several computerized ionospheric tomography (CIT) receivers deployed in the Caribbean region since July 1997. In this paper we compare CIT data, GPS TEC data, and data from the incoherent scatter radar at Arecibo to try to obtain an understanding of the temporal and spatial distribution of ionospheric structure observed during the campaign. We use the three data sets as inputs to the 3DVAR tomography algorithm developed at CIR and present results of the 3DVAR "objectively analyzed" electron density field. An ionization wall was found near 40° latitude in agreement with previous Millstone Hill and DMSP observations in high Kp. Several elongated density depletions were also detected.

3. Bust, Gary S., Clayton Coker, David S. Coco, Thomas L. Gaussiran II, and Todd Lauderdale, "IRI Data Ingestion and Ionospheric Tomography," Advances in Space Research, 2001 (accepted).

We present a method by which we combine IRI-95 predictions of electron density with ionospheric tomography data to provide an improved electron density estimate. We discuss the observation that IRI-95 produced ionospheres have a topside description which is too thick when compared to CIT reconstructions. A technique for ionospheric data ingestion is discussed. The algorithm is capable of ingesting GPS, DIT, ionosonde, and ISR data. The method is extensible to other types of data as long as a characterization of the errors can be obtained. We also discuss the study of latitudinal and longitudinal correlation in the ionosphere. Results of this correlation are shown for mid-latitude ionospheres over the Western U.S.

4. Bust, Gary S., D. Coco, and T. L. Gaussiran II, "Computerized Ionospheric Tomography Analysis of the Combined Ionospheric Campaign," Radio Science (submitted).

The Center for Ionospheric Research (CIR) at Applied Research Laboratories, the University of Texas at Austin (ARL:UT), has had several CIT receivers deployed in the Caribbean region since July 1997. Analysis of the CIT data from the first CIC campaign will be presented, and comparison with other data sets made. Analysis will initially focus on examining the TEC data from the CIT receivers and ground-based GPS TEC data, and correlating it with other data sets. Subsequently, the analysis will shift to performing 4-D electron density estimations using the IDA3D algorithm developed at CIR. The resulting electron density estimates will be compared with other data sources both for accuracy of the technique and scientific investigations.

5. Nieman, Linda T., Gerhard M. Krampert, and Robert E. Martinez, "An Apertureless Near-Field Scanning Optical Microscope and Its Application to Nanoscale Multiphoton Imaging," Applied Physics Letters (submitted).

We present a home-built apertureless near-field scanning optical microscope and results of its operation. Two-photon florescence imaging of coumarin I dye is shown with a spatial resolution below 50 nm. We also show enhanced second harmonic generation from CdSe quantum dots in the presence of a sharp gold-coated AFM tip.

6. Nieman, Linda T., Gerhard M. Krampert, and Robert E. Martinez, "An Apertureless Near-Field Scanning Optical Microscope and Its Application to Surface-Enhanced Raman Spectroscopy and Multiphoton Fluorescence Imaging," Reviews of Scientific Instruments (accepted).

We describe a home-built apertureless near-field scanning optical microscope and present preliminary results of its operation. Raman scattering from samples of polydiacetylene para-toluene sulphonate, and two-photon-induced fluorescence from crystallites of coumarin I dye, are strongly enhanced in the presence of a sharp gold-coated AFM tip. We verify the dependence of the scattered intensity on the polarization of the incident beam relative to the tip

axis. Finally, we show near-field fluorescence images taken in the presence of a strong far-field background whose spatial resolution is limited by the size of the tip.

2.2 COMPLETED DISSERTATIONS AND THESES

Bibliographical information on these academic documents is presented here. It should be noted that each of the graduates is a U.S. citizen, and each is a potential candidate for a leadership role in the conduct of future naval research and development.

1. Swalwell, Jarred (M.S., Electrical and Computer Engineering, August 1997). "Sonolysogenesis of Bacteria and Yeast."

2. Neiman, Linda Tae (M.A., Microbiology, May 2000). "Design and Construction of a Near-Field Apertureless Raman Microscope."

2.3 DISSERTATIONS AND THESES INITIATED

This project was initiated under the subject contract and is listed below. This project has now been reassigned to other funding sources.

1. Linehan, Daniel, "Higher-Order Statistical Analysis of Non-Linear Structural Response for Early Crack Detection," M.S. in Aerospace Engineering.

2.4 PAPERS PRESENTED AT MEETINGS

Titles, authors, and meeting data for papers presented at meetings are listed below. This listing does not include papers presented at meetings which have subsequently been issued as archival papers. Most, if not all, of the papers listed below will also be issued as archival papers. The presentation of scientific papers at meetings is a give-and-take process that enables the authors to receive criticism, comments, and an exchange of information that

sharpens the work perspective and its ultimate relevance prior to its submission as an archival contribution.

1. Knobles, D. P., "Extracted Seafloor Scattering Strengths Using Geoacoustic Inversion of Forward Data," ONR Shallow Water Reverberation Focus Workshop, Santa Fe, New Mexico, August 1999.

2. Knobles, D. P., R. A. Koch, L. A. Thompson, and K. C. Focke, "Sound Propagation in Shallow Water and Geoacoustic Inversion," International Conference on Acoustics, Noise, and Vibration, Montreal, Canada, August 2000.

3. Knobles, D. P., R. A. Koch, L. A. Thompson, and K. C. Focke, "Sound Propagation in Shallow Water and Geoacoustic Inversion," Acoustical Society of America, Atlanta, Georgia, July 2000.

4. Bust, Gary S., International Union of Radio Scientists (URSI), January 2001.

5. Bust, Gary S., URSI, August 2000.

6. Bust, Gary S., URSI, January 2000.

7. Bust, Gary S., International Reference Ionosphere Workshop, August 1999.

8. Martinez, Robert E., Society for the Advancement of Chicanos and Native Americans in Science, Washington, D.C., October 1998.

9. Martinez, Robert E., Federation of Analytical Chemistry and Spectroscopy Societies, Vancouver, B.C., Canada, October 1999.

10. Martinez, Robert E., American Physical Society, Minneapolis, Minnesota, March 2000.

11. Martinez, Robert E., Rutgers University Biomedical Engineering Department Colloquium, New Brunswick, New Jersey, May 2001.

2.5 DoD SCIENCE AND ENGINEERING APPRENTICESHIP PROGRAM

The purpose of the apprenticeship program is to provide outstanding recent high school graduates with hands-on experience in a stimulating research environment and encourage them to pursue careers in the science and engineering disciplines, particularly in those areas related to the needs of the Department of Defense. Students were selected for this program on the basis of their academic records, scholastic aptitude test results, and applications. Each student was assigned to a research project to be performed under the supervision of a research staff member at ARL:UT. At the end of the apprenticeship in mid-August, students gave oral presentations, using visual aids, for the Laboratories' directors, and prepared short technical papers summarizing their project results. The annual report included technical papers by the following student authors, whose abstracts appear below. Editing of the abstracts was minimal to preserve their originality of expression.

2.5.1 1998 Apprenticeship Program

1998 Participants

Lauren Alexander	Improving the Efficiency of CIT Data Management and Processing
Francisco Almaraz	Development of a 3-D Metadata Interface Environment
Clair Burns	Laser Measurements of Sand Bed Ripples
Tabrez Ebrahim	Detection and Distance Measurements via Infrared Sensors (DDMIS)
Jason Enelow	Testing of a Time Difference of Arrival (TDOA) Animal Geolocation System
Joe Flack	Boeing Aircraft Project
Igor Karpov	Web-Based Ionospheric Data Retrieval and Analysis Toolkit
Nirupa Raghunathan	Java-Based Data Management Tools
Ryan Rogers	Obstacle Avoidance Vehicle Simulator
Zackary Russell	Automation of Acoustic Field Measurements

Roseanne Schwartz	The Search for Sonar: An Attempt to Develop Stereo in ARL:UT's Large Outdoor Test Tank
Ellen Vanden Dries	Thrust Characterization of Variable-Voltage Electric Marine Motors
Marian Wu	Passive Acoustic Signatures of High Speed Boats

Abstracts of 1998 Apprenticeship Reports

1. Lauren Alexander: Improving the Efficiency of CIT Data Management and Processing.

Computerized Ionospheric Tomography (CIT) measures the density of the ionosphere using the total electron count (TEC) to produce a three- or four-dimensional model of the ionosphere. Collecting data requires the deployment of multiple receiver stations. Each of these stations consists of multiple parts, including a receiver and a computer that serves as a remote data acquisition site. Keeping an inventory of the equipment at these remote locations is important. Incoming data from the receiver stations must be processed, ridding the data of hardware-related errors. While collecting and processing CIT data, a method must be implemented to organize and provide easy access to it. Web pages were chosen to manage the data. Documentation explaining how to use all the tools necessary for CIT must be made accessible. Non-proprietary documentation software, specifically Extensible Markup Language (XML), served this purpose well.

2. Francisco Almaraz: Development of a 3-D Metadata Interface Environment.

Metadata is information about data. An example of metadata would be the author, publisher, copyright date, number of pages, and a summary for a book. All of this data is information about a book. In our case, the metadata is information about Web sites. The metadata is needed to help weed out undesired and unnecessary information. It assists in deciding which information is authentic, reliable, and most relevant.

3. Clair Burns: Laser Measurements of Sand Bed Ripples.

Over the past couple of months, I have been working under the supervision of Dr. Nicholas P. Chotiros to help develop a prototype system that will be mounted on a remotely operated vehicle (ROV) and used next fall in an ocean experiment. The goal of this prototype and experiment is two-fold. First, the system must scan with a laser along the bottom of an ocean and profile the roughness using a computer program currently being written. The purpose of the system is to find objects, such as mines, buried in the sand. Second, the system will use the sand bed surface patterns and the Fourier Transform process to provide data that can be used to predict the backscattering of sound waves and help prove the legitimacy of Biot's sound propagation theory.

4. Tabrez Ebrahim: Detection and Distance Measurements via Infrared Sensors (DDMIS).

The objectives of this project, often referred to as detection-on-the-move, are to detect intruders by moving a sensor a full 360 degrees and to determine if the object is human by comparing results from the various sensors. My portion of the entire detection-on-the-move project included the development of the general formula for measuring the distance from the center of the rotating platform to the detected object, so that this information could be compared with data from the other sensors to affirm that the object is human. Although this general formula was fairly accurate in determining the desired distance, there was an increasing percent error as one moved farther out from the center of the rotating platform. This was predominantly due to the poor quality sensors that were used.

5. Jason Enelow: Testing of a Time Difference of Arrival (TDOA) Animal Geolocation System.

The purpose of this project is to aid in the development of the Time Difference of Arrival (TDOA) Animal Geolocation System (TAGS). The TAGS is

a wildlife radio-location system which uses several stationary observation posts and a small portable transmitter attached to the animal to estimate its position.

6. Joe Flack: Boeing Aircraft Project.

Boeing Aircraft has asked the Signal Physics Laboratory of the Applied Research Laboratories to find a way to decrease the sound that an airplane or jet outputs during a routine landing. My goal was to capture video footage of an aircraft and import the video recording into a computer program called MATLAB, where we could extrapolate data and make calculations, such as the plane's velocity and height, with the touch of a button.

7. Igor Karpov: Web-Based Ionospheric Data Retrieval and Analysis Toolkit.

Java and related Internet technologies provide a powerful instrument for quickly developing lightweight, reusable, and platform-independent computer applications. They can be naturally incorporated into networks to open new possibilities in both collaborative efforts and in education. The ease of interconnectivity built into Java programming language allows integration of scientific equipment into computer networks for increased speed of data access and near real-time analysis. Ionospheric research, as a very data intensive field, easily lends itself to these types of applications. The potential for Java and related technologies is explored here through the development of an interactive, network-based application packet for near real-time retrieval and analysis of some simple ionospheric measurements.

8. Nirupa Raghunathan: Java-Based Data Management Tools.

The project that was assigned to me was programming a data management tool using relatively new languages such as Java and Hypertext Markup Language (HTML). The overall project took shape soon after the task of learning Java was complete. Java data management tools, which sort and

search data, were produced and incorporated on a Web page. Java was chosen because it is platform-independent and has become commonplace through its usage on the Internet.

9. Ryan Rogers: Obstacle Avoidance Vehicle Simulator.

Any vehicle collision suggests the necessity for an obstacle avoidance program that would direct the vehicle around obstacles. Obstacle avoidance programs are ideal for use in all types of vehicles including submarines, airplanes, boats, and cars. Self-piloted vehicles especially would benefit from the use of an obstacle avoidance program for safe navigation of the vehicle. Any autonomous vehicle, such as the Unmanned Underwater Vehicle (UUV), must be equipped with an obstacle avoidance program and would benefit greatly from further development of such programs.

10. Zackary Russell: Automation of Acoustic Field Measurements.

This project focused on automating a function generator, three-axis positioning equipment, and a digital oscilloscope to take acoustic field measurements as a function of position. Primarily, measurements were taken in a water-filled cylinder of piezoelectric material. The purpose of this experiment was to determine the sound field within the cylinder that was driven at ultrasonic frequencies. Using the data acquired from this experiment, we were able to analyze the acoustic properties of the cylinder for comparison with a theoretical model. Automated measurements were also conducted to study the sound field in the air radiated from various noise sources, such as desktop computers.

11. Roseanne Schwartz: The Search for Sonar: An Attempt to Develop Stereo in ARL:UT's Large Outdoor Test Tank.

The objective of my summer project at Applied Research Laboratories (ARL) was to produce stereo sonar, whose quality and level of detail is equal to that of medical ultrasounds, in the large ARL outdoor test tank. After a 90-in.

array was modified to conform to the project, it was tested in ARL's test tank using a software system set up by previous students. Although over ten separate tests were performed with different hydrophones and transducer, conclusive sonar signals were not received until the end of the summer. The main problems were due to mechanical failures and a lack of documentation from previous students, but the array is now operational and ready to begin collecting data for stereo sonar.

12. Ellen Vanden Dries: Thrust Characterization of Variable-Voltage Electric Marine Motors.

ARL:UT is refining the Portable Impact Location (PILS) with station-keeping capability in continued support of the Fleet Ballistic Missile (FBM) program. The PILS is currently used to locate re-entry bodies of the Trident II missiles. Enhancements on PILS include motors that will be integrated into the PILS II station-keeping sonobuoy (PASS) to provide them with the means to drive and maintain their respective array positions. The purpose of this experiment was to discover the optimal operational conditions for two motors, which would then allow for the selection of the motor most suitable for the task. This report details the process of designing a test apparatus for determining the thrust output as a function of voltage for two variable-voltage electric motors, building the mount, then testing the motors. The two motors are the engine-mounted Minn Kota EM42 and the transom-mounted Motor Guide trolling motor.

13. Marian Wu: Passive Acoustic Signatures of High Speed Boats.

In this report, we will introduce a method of detecting high speed boats by recording and analyzing underwater acoustic signals. We conducted several experiments at the Lake Travis Test Station (LTTS) using a variety of water craft ranging from small motorized skiffs to larger, more powerful ski boats. In these experiments, we acquired acoustic data with a vertical array of hydrophones submerged beneath the test station and an air microphone located above the array. After collecting and recording the data, we analyzed it

to discover potential physical discriminates of the water craft used in the experiment. Presumably, propeller rotation, piston motion, and other engine related sounds will comprise the prominent acoustic features of the boat data. It is also expected that broadband noise, such as spark plug ignition action, will be emitted from the engines. Because the periodic or tonal sounds are typically easier to process, our analysis will focus on the frequency domain of the signal. This report will also briefly mention the global positioning system (GPS) used to measure and record the time-varying range between the boat and the array.

2.5.2 1999 Apprenticeship Program

1999 Participants

Alexis Battle, Tiffany Wallis	The Utilization of Java Server-Side Programs for Ionosphere Imaging and Data Analysis
Gregory Beaman	Testing Electric COTS Motors for Underwater Applications
Katherine Cheng	Implementation of ARTEPs into CLIPS
Paul Helweg	Unmanned Undersea Vehicle (UUV)
Matthew Fox	Acoustic Agglomeration of Particulate: Measurements as a Function of Frequency, Sound Pressure Level, and Concentration
Hector Mendez	PILS II Buoy: Design of Hydrophone and Scuttle Mechanisms
Danielle Moten	Development of a Prototype Underwater Probe Vehicle
Ross Patterson	Prototype Underwater Probe Vehicle
Sarah Pettengill	Improvement of Type and Weight Classifications Made by the Seismic Processing System of a Vehicle Detection Unattended Ground Sensor
Elizabeth Pontius	Data Warehouse Analysis Tools: Breaking Technology
Patrick Smith	Stereo Sonar: The Approach and Its Obstacles
Jesse Ziser	DMMS-DRIS DIF Stylesheet Project

Abstracts of 1999 Apprenticeship Reports

1. Alexis Battle and Tiffany Wallis: The Utilization of Java Server-Side Programs for Ionosphere Imaging and Data Analysis.

The goal of our summer project was to graph raw data, which was collected in August and September of 1998 and which measured the intensity of electrons in the ionosphere above a portion of the globe. For approximately one month, stations on the ground took measurements of a portion of the ionosphere above the region of the Earth defined by the latitude lines 5.3N and 70.2N and the longitude lines 200 and 275. Our assignment, originally entitled "Improving Web Presence of Ionospheric Data," was to learn a computer programming language and then write a series of programs which would graph this data and put it on the Web where it could be more easily studied and understood by the scientists analyzing the ionosphere.

2. Gregory Beaman: Testing Electric COTS Motors for Underwater Applications.

The Signal Physics Laboratory of Applied Research Laboratories, The University of Texas at Austin (ARL:UT), attempted to design a winch for the Autonomous Acoustic Sensor System (AASS Project) buoy. This winch would be required to release an anchor to the ocean floor and then, when signaled, to surface and return back to its position of rest at thirty feet below the surface. Using a lithium battery supply, we were given an estimated power budget and limitations of the system. Based on these figures we set out to find a small efficient motor that would drive our system using such a small voltage supply. It became evident that we would need to devise a method to test and prove the capabilities of the candidate motors, so we began to design a dynamometer for such a purpose.

3. Katherine Cheng: Implementation of ARTEPs into CLIPS.

The National Training Center (NTC) organizes and conducts live war training simulation using high-tech laser equipment. To help coordinate their work, the Objective Instrumentation System (OIS) will allow thousands of players to participate in action as well as allow for after-action review support; NTC-OIS is expected to be the next generation of instrumentation. Knowledge-based expert systems could possibly hold the answer for future army work. This paper studies the implementation of army training evaluation plans (ARTEPs) into an expert system, a component of artificial intelligence. The paper begins with a discussion of NTC-OIS, followed by its relationship to data analysis, and then a description of expert systems, with a special focus on the C Language Integrated Production System (CLIPS). The paper then continues to outline the actual work that was done during this summer research program: implementing ARTEPs into CLIPS.

4. Paul Helweg: Unmanned Undersea Vehicle (UUV).

The purpose of this project was to design and build a relatively inexpensive and easily duplicated submarine that could, in the future, be used as a reconnaissance vehicle. No restrictions on size and weight were given; however, general directions specified to build the submarine as large as possible. The plans for this project will be used as a test bed from which later submarine designs can be created. The overall purpose is to improve the original design of the submarine. The addition or removal of components such as sonar arrays, along with various other pieces of underwater equipment, is a possibility in future models.

5. Matthew Fox: Acoustic Agglomeration of Particulate: Measurements as a Function of Frequency, Sound Pressure Level, and Concentration.

Current technology is unable to meet desired atmospheric emission standards at lignite-fired power plants, such as those of our sponsor, Texas

Utilities Corporation (TXU). Of specific interest is the reduction of fine particulate atmospheric emissions, such as fly ash produced by burning lignite coal. Acoustic agglomeration, one of the only known processes able to address this issue, ameliorates the problem by forcing small particulates to stick together to form larger, more easily filtered strings of particles. This process would be a key innovation at lignite-fired (coal) plants, where the resulting particulate is too small, i.e., < one micrometer size, to be easily collected by industrial filters. However, only limited research exists that deals with an in-depth analysis of the acoustic agglomeration process. The goal of this summer research project is to confirm the important factors in, and to determine some of the initial optimal conditions for, the application of acoustic agglomeration for particulate emissions control.

6. Hector Mendez: PILS II Buoy: Design of Hydrophone and Scuttle Mechanisms.

Applied Research Laboratories, The University of Texas at Austin (ARL:UT), is currently upgrading the Portable Impact Location System (PILS) program to utilize a station-keeping sonobuoy. The PILS buoy is used to locate re-entry bodies of the Trident II Missiles. Because of a different deployment method, i.e., ship deployment instead of an airplane deployment, the hydrophone deployment mechanism had to be redesigned. The purpose of the research was to discover the optimal method of deploying the hydrophone and, if needed, scuttling the buoy. This report depicts the process of designing, constructing, and testing new deployment and scuttle mechanisms for the PILS II sonobuoy. The primary mechanisms used for the hydrophone deployment and scuttle mechanism were 12-volt solenoid valves.

7. Danielle Moten: Development of a Prototype Underwater Probe Vehicle.

Over the past few months, I have been working with Jeff Gensler, Perfecto Martinez, Paul Halweg, and Ross Patterson under the supervision of Steven Morrissette, Charles Loeffler, and Terry J. Brudner to create a prototype

test bed, or an Unmanned Underwater Vehicle (UUV). The goal of this vehicle is to house and transport sonar equipment under water. The sonar, or acoustic sensor, is capable of mapping the floor of Lake Travis and, perhaps, the ocean. The UUV's design requires it to be operational at a maximum of two hundred feet and possibly up to ocean depths.

8. Ross Patterson: Prototype Underwater Probe Vehicle.

For the summer of 1999, I participated in the High School Apprenticeship Program at Applied Research Laboratories, The University of Texas at Austin (ARL:UT). For two and a half months I have worked on a group project within the Sonar Development Division (SDD) of the Advanced Technology Laboratory to help develop an unmanned underwater vehicle (UUV). The stated objective of this project was to design, construct, and test a small, inexpensive, underwater probe vehicle that would function at shallow depths. Once constructed, the vehicle would be improved with different types of sonar, radio links, and various mechanical systems, allowing it full ocean depth. This would be a prototype for what would eventually become an autonomous vehicle that could be produced relatively inexpensively and in large numbers. The group that worked on this summer project was composed of two senior University of Texas at Austin engineering students and three high school apprentices.

9. Sarah Pettengill: Improvement of Type and Weight Classifications Made by the Seismic Processing System of a Vehicle Detection Unattended Ground Sensor.

A vehicle detection sensor that could detect and classify vehicles, particularly SCUD missile launchers, is under investigation by the Environmental Sciences Laboratory of the Applied Research Laboratories, The University of Texas at Austin (ARL:UT). At the beginning of the summer, the classification program had been written in its entirety. Sara Orton (ARL:UT Honors Scholar) and I worked this summer on improving the traction (wheeled

or tracked) and weight algorithms. We made improvements to these algorithms by using a history of the event, enabling us to use the best data. Using only the data in the CPA window, we could get more accurate traction mechanism predictions. The previous way of finding relative weight relied on maximum signal-to-noise ratio (SNR) values and velocity guesses. We discovered that the velocity guess was vehicle dependent and could not be used. We developed a new method of finding relative weight using the maximum SNR and the number of scans, but further testing is necessary before this weight algorithm is fully implemented.

10. Elizabeth Pontius: Data Warehouse Analysis Tools: Breaking Technology Barriers for the Intelligence Community.

The Applied Research Laboratories, The University of Texas at Austin (ARL:UT), has been working for roughly two years to develop a data warehouse for the Air Force Information Warfare Center (AFIWC) located at Kelly Air Force Base in San Antonio, Texas. AFIWC will use this data warehouse to gain insight into adversary military operations and to support information operations analysis and knowledge discovery. Air Force Intelligence analysts will use commercial off-the-shelf (COTS) software tools to analyze the data in the warehouse and display the results. This paper describes the research and recommendation of COTS tools to include in the final delivery of the AFIWC Data Warehouse (ADW).

11. Patrick Smith: Stereo Sonar: The Approach and Its Obstacles.

The purpose of this project was two-fold. First my colleague Jeff Triffo, Honors Scholar at Applied Research Laboratories, The University of Texas at Austin (ARL:UT), and I were assigned to create concept stereo sonar images using a small, diver's hand-held unit (DHU), also created within ARL:UT. Second, Jeff and I were to reassemble, test, and debug a larger sonar unit, used in ARL:UT's large test tank to create high-resolution stereo sonar images.

These images were to show the potential of stereo sonar as an imaging and underwater search technique.

12. Jesse Ziser: DMMS-DRIS DIF Stylesheet Project.

The Conceptual Models of the Mission Space Data Representation Interchange Specification Data Interchange Format (CMMS-DRIS DIF) is a data format designed to transfer information between data systems with mission simulation system specification information. Since these data systems often differ in their internal methods of representing the data, the CMMS-DRIS DIF provides a common format through which data systems with totally different internal formats can communicate simulation model data. This DIF was designed to be written and read by computer programs; however, there may be some situations in which a human would actually need to see the data being sent. The Extensible Stylesheet Language (XSL) stylesheets provide an ideal interface between the user and the CMMS-DRIS DIF document, since the CMMS-DRIS DIF document is simply an Extensible Markup Language (XML) document. XSL is considered the standard format for describing to a viewer program how to display an XML document. The viewer for which our stylesheet was designed is Internet Explorer 5.0.

REFERENCES

1. ARL:UT proposal Ser P-1682, dated 1 November 1995, from Dr. F. Michael Pestorius, ARL:UT Director, to Dr. Jeffrey A. Simmen, ONR Code 321OA, for $800,000 for the performance period 1 January 1996 through 24 months.

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15 January 2002

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